



Armed Forces College of Medicine AFCM

Neuroscience Module

New Five Year Program



THALAMUS & HYPOTHALAMUS & LIMBIC SYSTEM

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INTENDED LEARNING OBJECTIVES (ILO)

By the end of this lecture the student will be able to:

- List the nuclear groups of the thalamus.
- List the thalamic connections with the different centers.
- Describe why the thalamus is important center and list its functions.
- Describe the functions of hypothalamus.
- List the component of the limbic system & describe its functions.



1. Part 1 (5 min) **Introduction to functional divisions of thalamic nuclei and its connections**
2. Part 2 (35 min) **Main lecture:**
 - 1. Function of thalamus**
 - 2. Function of hypothalamus**
 - 3. Function of limbic system**
3. Part 3 (5 min) **Summary**
- 4. Lecture Quiz (5 min)**

THALAMUS

GATEWAY TO THE CEREBRAL CORTEX

Participates in sensory, motor
and integrative functions.

THALAMIC NUCLEI

Functionally; *thalamus divided into:*

1- Specific projection nuclei

2- Non specific projection nuclei

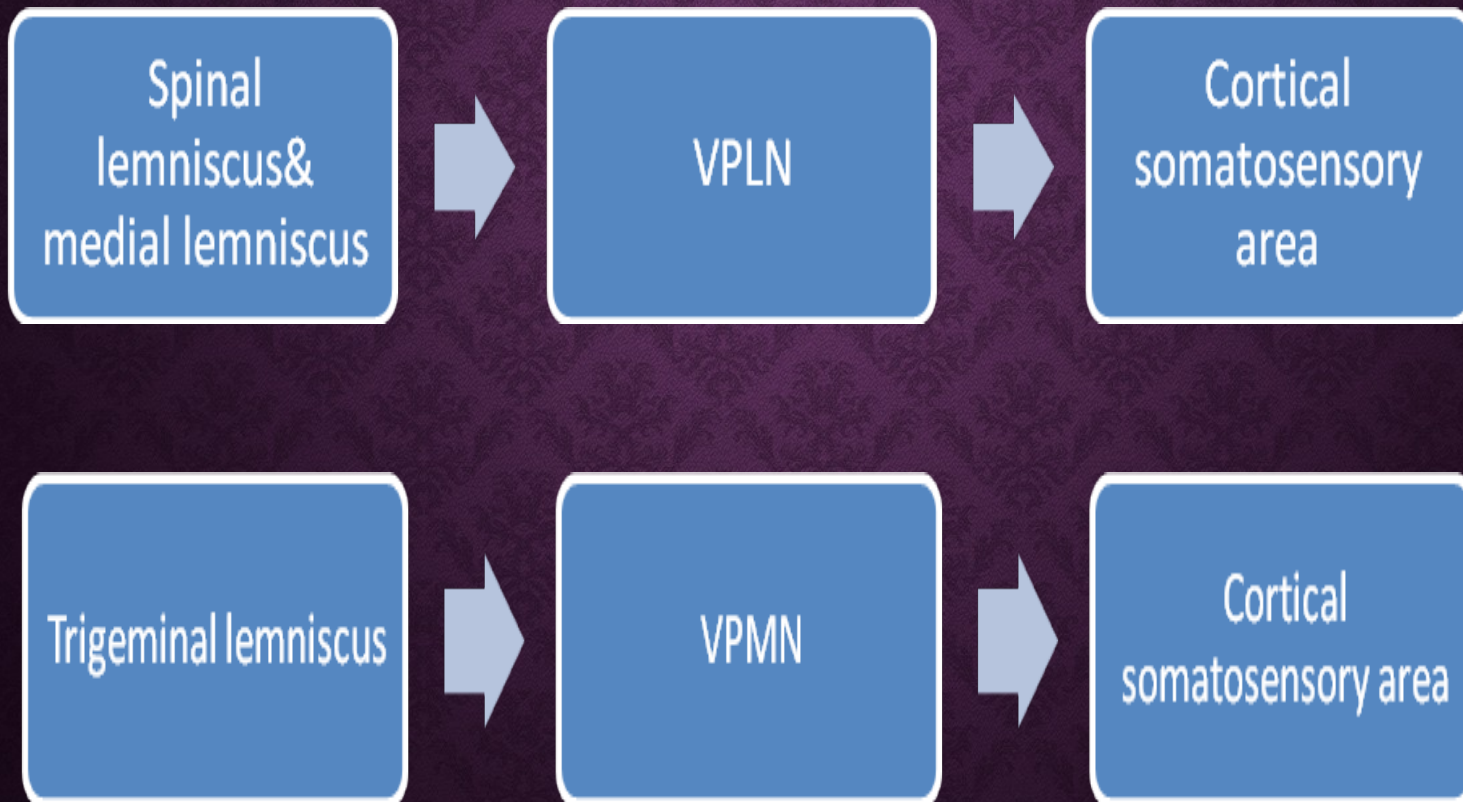
THALAMIC CONNECTIONS

(A) Nonspecific projection nuclei:



(B) Specific projection nuclei:

(1) Ventro-posterior nucleus (VPN):



(B) Specific projection nuclei:

(2) Lateral geniculate body (LGB):



(3) Medial geniculate body (MGB):



(B) Specific projection nuclei:

(4) Ventroanterior (VA) & Ventrolateral nucleus (VL) (thalamic motor nuclei):



(B) Specific projection nuclei:

(5) Anterior nucleus:


- Involved in memory and emotions.



(6) Dorsomedial and dorsolateral nuclei (association nuclei):

- Involved in higher intellectual function, behavior and perception



		<div>Output=</div> <div>Project to</div> <div>→</div>	Thalamic nucleus	<div>Input=</div> <div>From</div> <div>→</div> <div></div>
Non specific projection thalamic nuclei		Almost all areas of the cerebral cortex	Midline& intralaminar nucleus	
Sensory	Specific projection thalamic nuclei	Cortical somatosensory area (Postcentral gyrus)	VPLN	Spinal lemniscus& Medial lemniscus
		Cortical somatosensory area (Postcentral gyrus)	VPMN	Trigeminal lemniscus
		Visual (Occipital) cortex	LGB	Visual impulses
		Auditory (Temporal) cortex	MGB	Auditory impulses
Motor		Cortical motor areas	VA & VL	Cerebellum & Basal ganglia
Integrative		Cortical limbic lobe	Anterior nucleus	Hypothalamus (Mamillary bodies)
		Cortical association areas	DM & DL	Other thalamic nuclei

FUNCTIONS OF THALAMUS

	Sensory	Motor	Integrative
ARAS (Sleep & Consciousness).	<ul style="list-style-type: none">- Relay station for all epicritic sensations, vision and hearing.- Center of perception of protopathic sensations.	<ul style="list-style-type: none">- Relay station for signals from contralateral cerebellum, ipsilateral basal ganglia.	<ul style="list-style-type: none">-Memory and Emotions.-Personality and behavior.-Higher intellectual functions.

Thalamus (Quiz)



Complete:

1- Basal ganglia connected to the cerebral cortex
VA, VL
ipsilateral
through.....thalamic nucleus.

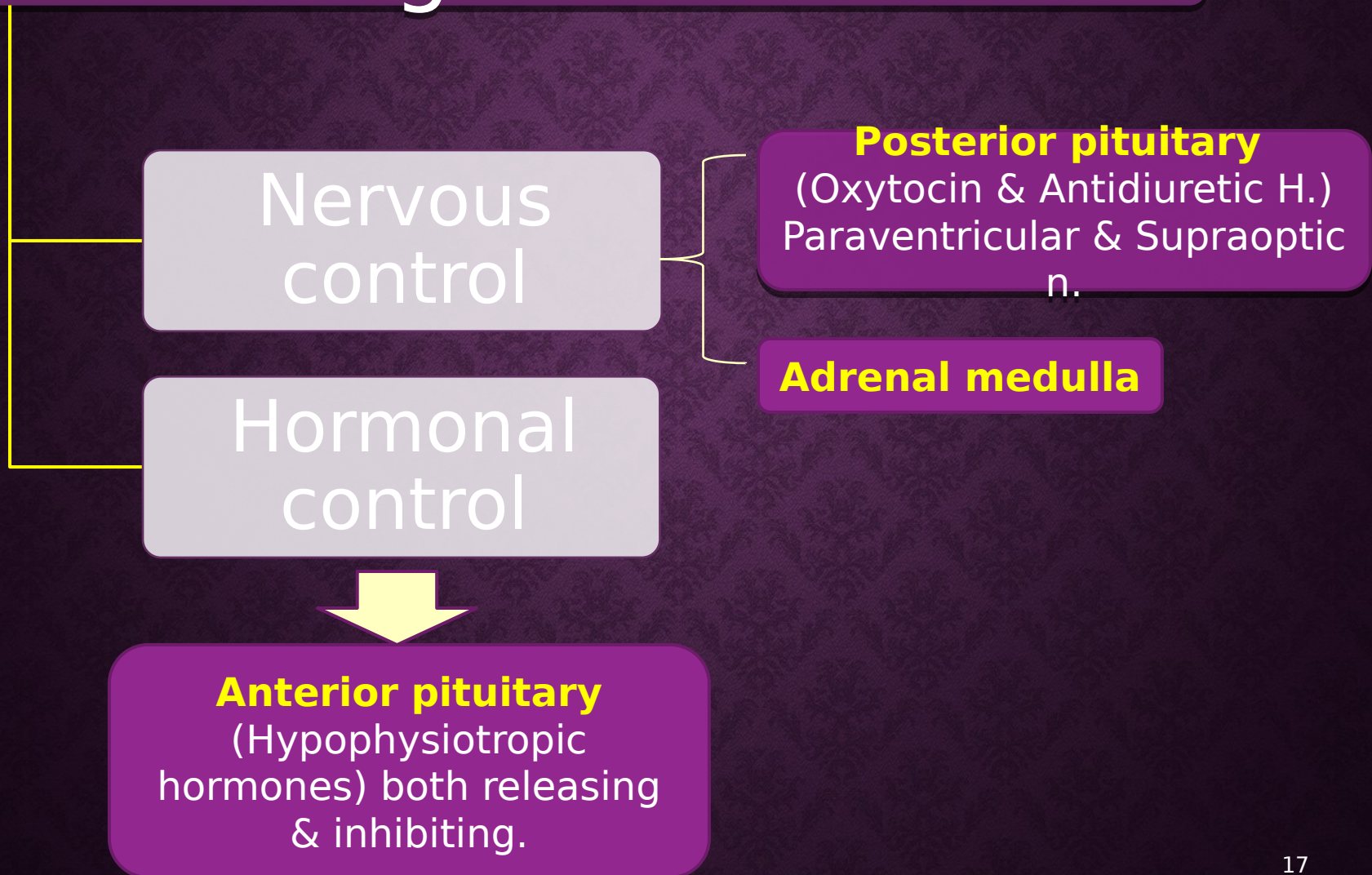
2- Integrative function of the thalamus is mediated
Anterior, dorsomedial,
dorsolateral
by.....thalamic nuclei

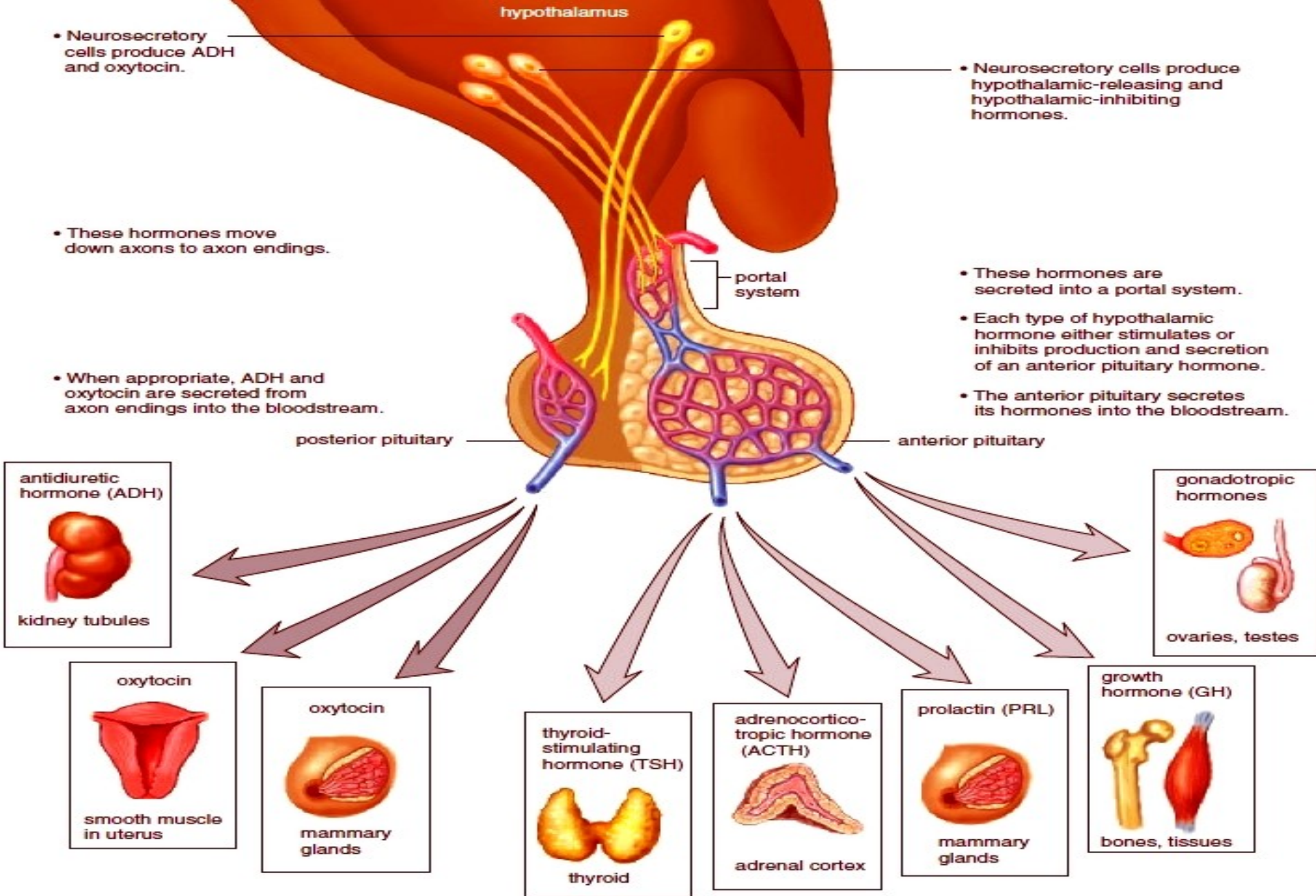
HYPOTHALAMUS

FUNCTIONS OF HYPOTHALAMUS

(THE MAJOR HOMEOSTATIC ORGAN)

1- Control of Endocrine glands





2- Control of autonomic nervous system

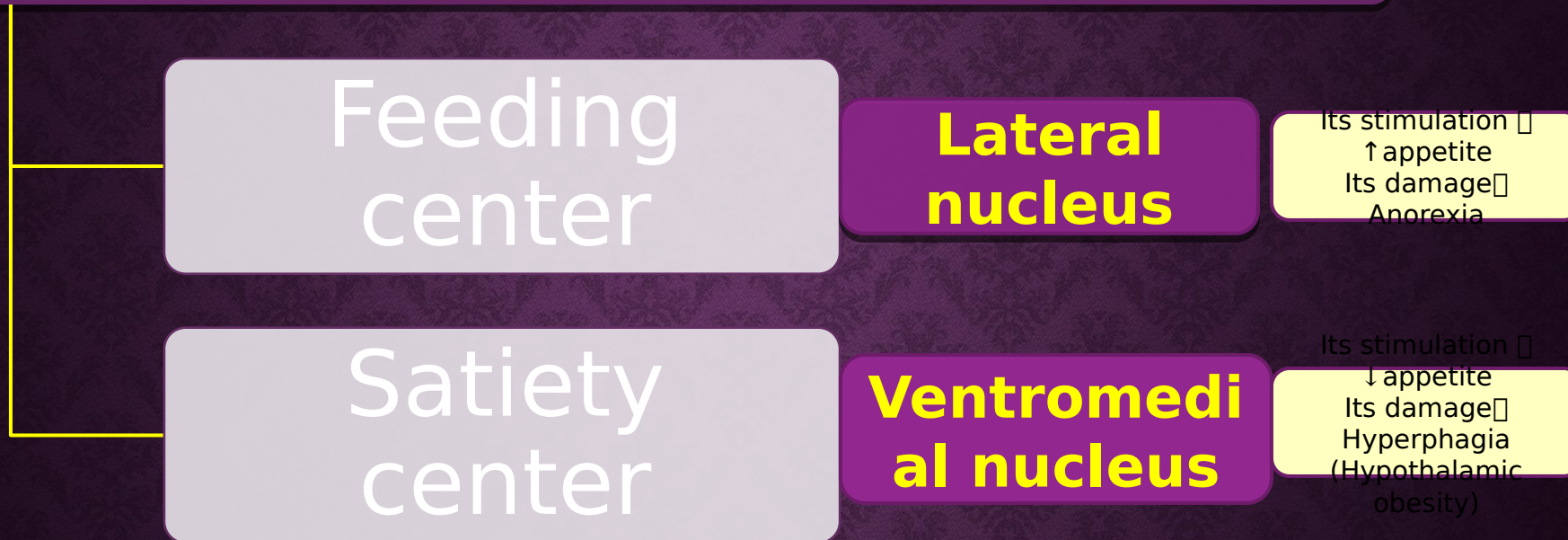
Sympathetic
nucleus

**Posterolateral
part**

Parasympathet
ic nucleus

Anterior nuclei

3- Control of food intake and appetite (Appetstat) *reciprocally controlled*



- Feeding center is always active.
- It can be inhibited by satiety center, which contain glucoreceptors (glucostat), when blood glucose increases after meals this stimulate satiety center, thus inhibiting feeding and producing satiety.

Entrance of glucose to satiety center is insulin dependent this explains excessive hunger noticed in diabetic patients.

4- Control of water balance

Water
intake

**Thirst center
in lateral nuclei**

Water
output

**ADH
from supraoptic
nucleus**

Also, hypothalamus contains **osmoreceptors**

3- Control of body temperature

(Thermoregulatory center = Thermostat)

Heat gain center

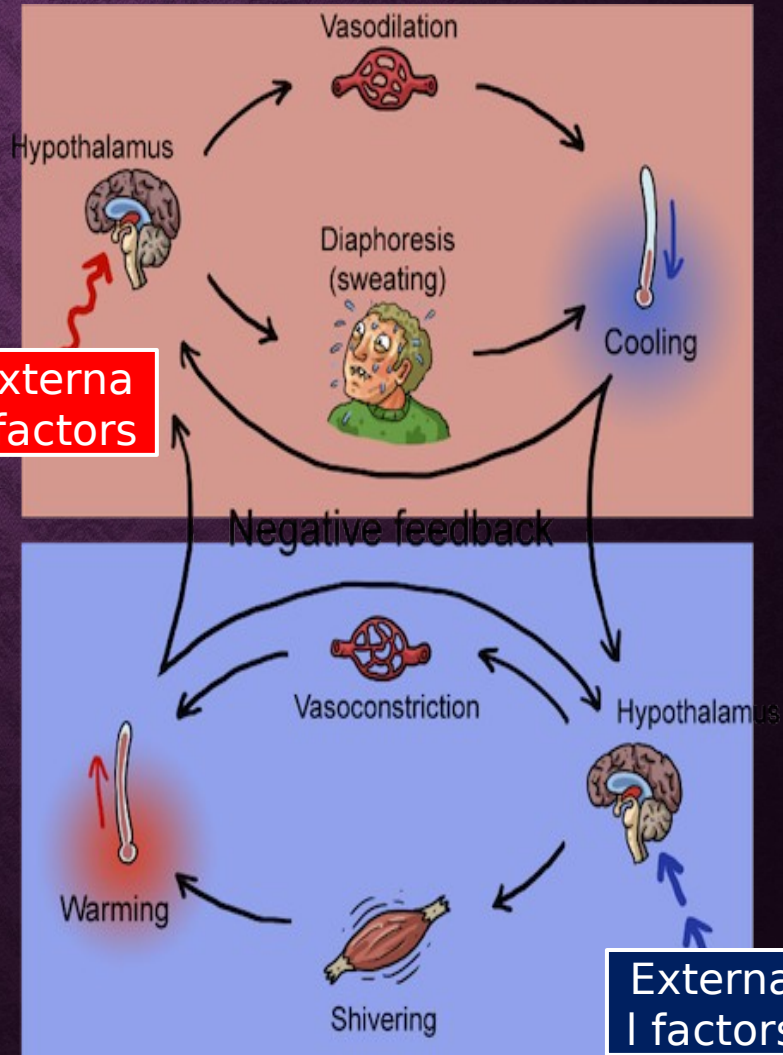
Posterior nuclei

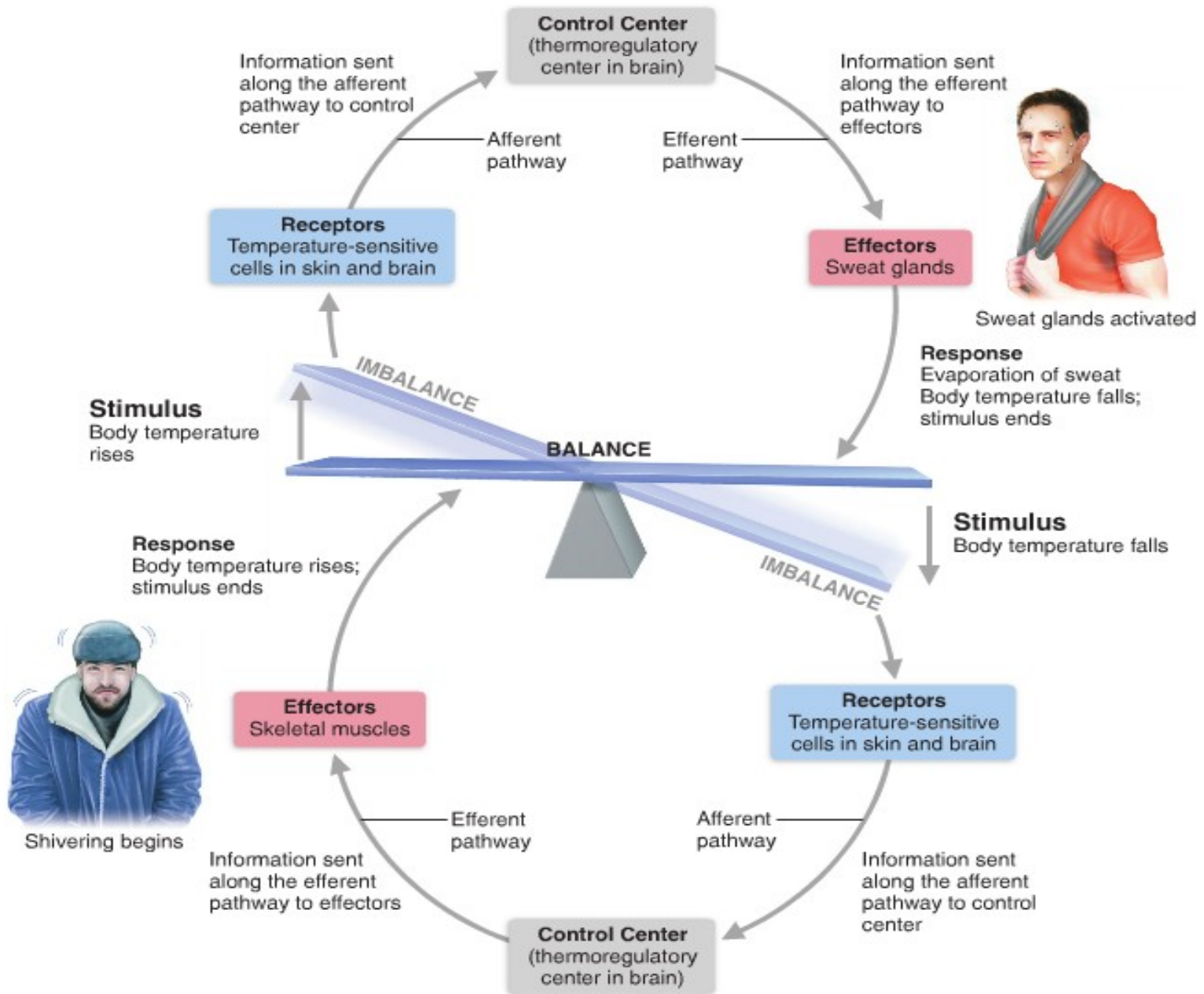
Heat loss center

Anterior nuclei

External factors

Also, hypothalamus contains **central thermoreceptors**

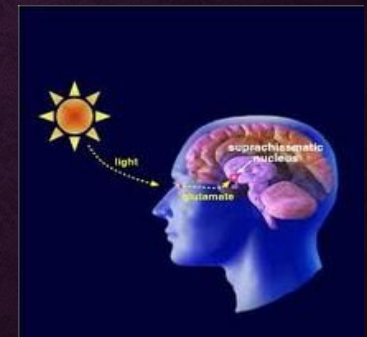




6- Control of sleep

Sleep center
(Diencephalic sleep zone in posterior hypothalamus)

Control of circadian rhythm
(Suprachiasmatic n.)



Suprachiasmatic N. is the pacemaker for many circadian rhythms:

- Secretion of hormones e.g. ACTH, Growth H. and Melatonin
- Body temperature
- Sleep-Awake (24 h. light-dark) cycles

7- Control of

```
graph LR; A[7- Control of] --- B[Motivation  
(Rewarding & Punishment centers)]; A --- C[Emotions]; A --- D[Behavior];
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Motivation
(Rewarding & Punishment centers)

Emotions

Behavior

With limbic system

Functions of the Hypothalamus

Anteriorly is the radiator (Cooling)

Anterior n.

Heat loss
parasympathetic

Sun roof (suprachiasmatic) when you see the stars you want to go to sleep => circadian rhythm

Lateral n.

Laterally is the gas cap

Feeding
Thirst

Ventromedial n.

the gas tank

Satiety

Posterior n.

Heat gain
Sympathetic

Posteriorly is the exhaust (Heating)

Punishment centers & Pain analgesia system: periventricular,

Reward centers

Hypothalamus (Quiz)



Which of the following hypothalamic nuclei is involved in thermoregulation?

- a. Lateral nucleus.
- b. Ventromedial nucleus.
- c. Paraventricular nucleus.
- d. Anterior hypothalamus.**
- e. Suprachiasmatic nucleus.

LIMBIC SYSTEM

It is the neuronal circuits that control emotions, motivation and behavior.

Consists of Limbic lobe + Subcortical structures

Functions of limbic system

1- **Olfaction (Smell)**

Limbic system is responsible for:

- Perception** and **discrimination** of olfactory stimuli (**Piriform cortex**).
- Emotional reactions** associated with olfactory stimuli (**Amygdala**).
- Olfactory memory** (**Entorhinal cortex**).

2- Control of **autonomic response**

Limbic stimulation produces autonomic effects (e.g. changes in ABP, respiration) which are parts of the emotional responses.

Functions of limbic system

3- Control of **feeding behavior**

Limbic system is involved in the **neuronal regulation of appetite**. Lesions of **amygdaloid nuclei** → **hyperphagia** (increase eating) and **amniophagia** (indiscriminative ingestion of all kinds of food).

4- **Maternal and sexual behavior**

Limbic system is important for normal maternal behavior and is concerned with emotional expression during the sexual act.

Functions of limbic system

5- Control of **emotions**



Both limbic system and hypothalamus are concerned with genesis of emotions, and control of their associated responses. Emotions may be associated with:

1- Autonomic response: Changes in HR, ABP, respiration, sweating, pupillodilatation.

2- Endocrine response: Release of CRH, CAs during stress.

3- Somatic response: Exaggerated reflexes in anxiety.

6- Relation to **memory**

Hippocampus is the site of **encoding** and **consolidation** of short term memory.

Bilateral lesion of hippocampus leads to **anterograde amnesia**.

Functions of limbic system

7- Motivation

Def.: It is the force that **activates** or **inhibits** certain behavior to achieve certain goal. Limbic system has **two centers** that control motivation:

Reward (approach) system

Lateral and **ventromedial nuclei** of the hypothalamus & part of Amygdaloid nucleus.



Pleasure, satisfaction, ecstasy.

Continue doing the act
Repetition

Punishment (avoidance) system

Periventricular nucleus of the hypothalamus and **Periaqueductal gray area** & part of Amygdaloid nucleus



Displeasure, fear, terror.

Stop doing the act
Avoidance

Its stimulation leads to

Limbic System (Quiz)



ABOUT THE LIMBIC SYSTEM:

A- IT CONSISTS OF ONLY A RING OF HIGHLY DEVELOPED CORTICAL TISSUE.

B- IT INCLUDES THE RED NUCLEI AND SUPERIOR GYRI.

C- IT IS CONCERNED WITH TEMPERATURE REGULATION & LANGUAGE FUNCTIONS

D- IT HAS NO RELATION TO FOOD INTAKE.

**E- LESION INVOLVING THE HIPPOCAMPUS PRODUCES
AMNESIA**

SUMMARY



Functions of

Hypothalamus (7)	Limbic System (7)
Endocrine	Olfaction
Autonomic	Autonomic
Food intake	Feeding behavior
Water balance	Maternal, Sexual behavior
Temperature balance	Emotions
Sleep	Memory
Emotions, Behavior, Motivation	Motivation

SUGGESTED TEXTBOOKS



1. Ganong's review of medical physiology

25th edition

2. Guyton and Hall 13th edition

A photograph of several purple globe amaranth flowers in a field. The flowers are in various stages of bloom, with some in sharp focus in the foreground and others blurred in the background. The background is a soft, out-of-focus mix of green and yellow, suggesting a sunny day in a garden or field.

THANK YOU

Rangan Das

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